Summary of Conclusions of the

MACKENZIE ENVIRONMENTAL MONITORING PROJECT

Prepared for: Government of the N.W.T.
Department of Renewable Resources
Policy and Planning Division
Yellowknife N.W.T.

Prepared by: Debbie DeLancey
Fee-Yee Consulting Ltd.

February 1987

TABLE OF CONTENTS

INTRODUCTION:

PURPOSE OF THIS REPORT

The Mackenzie Environmental Monitoring Project (MEMP) addressed a number of environmental issues that are of concern to the residents of the MEMP Region - that is, the Mackenzie Valley from Fort Norman north, the Mackenzie Delta and the Beaufort Peninsula. The organizers of the MEMP project made an effort to include community representatives in the project and to ensure that community concerns were dealt with.

However, the final MEMP Report is a large, complex and often confusing document. The Department of Renewable Resources produced this summary of the MEMP Report in order to make the MEMP conclusions more understandable and more accessible to the general public.

In this document we have summarized the results of the MEMP project, and re-organized them for easier reference.

The conclusions presented here were arrived at by the MEMP working groups after lengthy discussion. They are not official positions of the Department of Renewable Resources and do not necessarily reflect the research and monitoring priorities of the Department.

ACKNOWLEDGEMENTS

The Department of Renewable Resources gratefully acknowledges the financial assistance of NOGAP (Northern Oil and Gas Program), of the Department of Indian and Northern Affairs in Ottawa, which made the production of this report possible.

The author thanks all those people who were consulted in the course of this project, including:

Jim Allard, Fort Good Hope

Edna Elias, Yellowknife

David Krutko, Fort MacPherson

Frank Pope, Norman Wells

Dave Sullivan, Inuvik

Dave Sutherland, Yellowknife

Lucy-Anne Yakelaya, Yellowknife.

WHAT IS MEMP?

"MEMP" stands for the Mackenzie Environmental Monitoring Project. The program was a joint project of Indian and Northern Affairs, Environment Canada, Department of Fisheries and Oceans, GNWT Department of Renewable Resources, and the Yukon Territorial Government.

MEMP was designed because of the concerns that oil-and-gas related development activity in the Beaufort Sea, Mackenzie Delta, and Mackenzie Valley regions would have negative environmental impacts. The government departments recognized that there was a need for environmental research, and monitoring programs, that would be tied to the present and future exploration and development plans for the region.

MEMP was set up to identify the research and monitoring needs, and to come up with a monitoring/research program that is useful and practical, and flexible enough to respond to changes in the development plans.

The MEMP study area is shown in Figure 1. It includes the Tuktoyaktuk Peninsula, the Mackenzie Delta, and the Mackenzie Valley south to Fort Norman.

The conclusions in this report were arrived at through a series of workshops and discussions which included scientists, staff people from the government departments involved in the project, representatives of Mackenzie Valley native groups, community representatives, and some consultants. A list of participants is included at the end of this report.

People who took part in the first set of workshops were asked to identify the parts of the environment that could be affected by development activities. The list included:

- air quality
- water quality
- landscape quality
- population, harvests and quality of wildlife.

Workshop groups then discussed what impacts might affect each of those things. The final result of these discussions was a list of what scientists call hypotheses. Hypotheses are ideas about something that might happen under certain circumstances, but the ideas have not been tested yet. In this paper, instead of using the term "hypothesis", we use the term "possible problems".

Another set of workshops was held several months later, at which people with an interest in each of these parts of the environment talked about the possible problems in detail, and decided whether they thought the impacts were likely to occur. They also talked

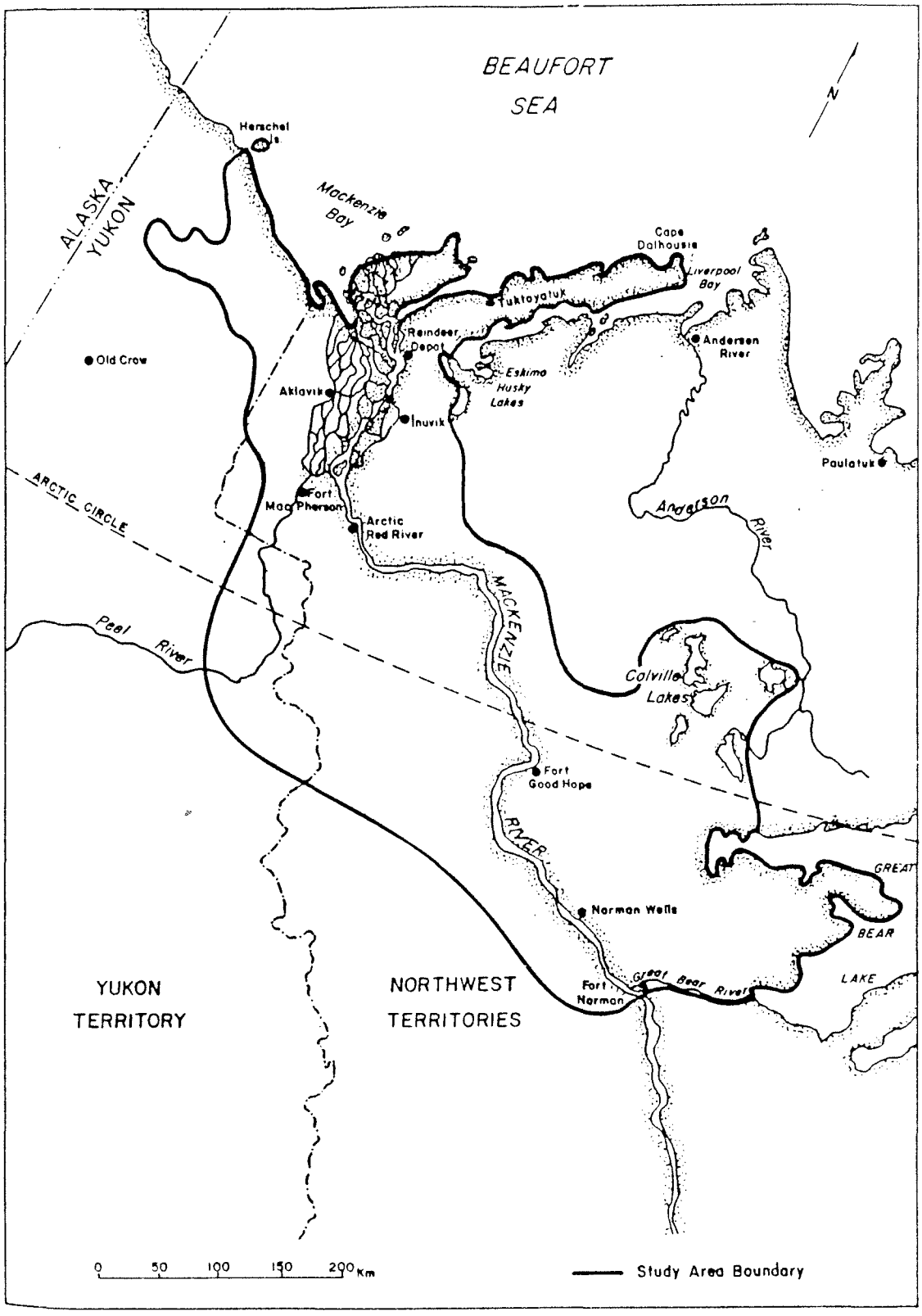

Figure 1 Proposed boundaries of the MEMP study area.

about what kind of research and/or monitoring programs would be needed to understand the problem and figure out how to avoid, or deal with, the negative impacts.

Proposed Development Activities:

MEMP was designed to predict the likely environmental impacts of hydrocarbon (oil and gas) exploration and development. Although development proposals and activities change from year to year with the price of oil and other factors, the MEMP exercise was based on the assumption that oil-and-gas related activity would follow a fairly predictable pattern.

People who took part in the MEMP workshops assumed that the activities which would take place were basically those outlined in the Environmental Impact Statement for Beaufort Sea development, and the Polar Gas proposals; as well as on-going activities associated with Norman Wells. Specific activities predicted included:

- construction and operation of gas processing facilities;
- construction and operation of oil processing facilities;
- construction and operation of support facilities;
- oil pipelines;
- gas pipelines;
- staging sites on the river and delta;
- airstrips;
- all-weather roads;
- seismic activities;
- exploration activities;
- operation of a topping plant;
- gravel pits and quarries;
- material removal in general;
- water withdrawals;
- emissions into the air;
- causeways;
- waste disposal;
- reservoir pumping;
- consumption of power by industry;
- oil spills;
- spills of toxicants (pollutants);
- sewage effluent.

It was assumed that activities would take place primarily in the Norman Wells area, the Colville Lake area, and the Mackenzie Delta area.

Format of this Report:

This report presents, in summary form, the 25 hypotheses or possible problems, that were discussed at the workshops. For each problem we have outlined:

- a statement of the possible problem;
- background information;
- reasons why the problem was predicted;
- conclusion - why the problem is or is not likely to occur;
- research and monitoring recommended by the workshops;
- other recommendations.

The possible problems have been grouped in three categories.

* Group A includes those problems which MEMP decided were likely to occur, and likely to have serious impacts (or impacts which could be serious if the problem is not dealt with)

* Group B includes those problems which MEMP decided were possible, or likely to occur, but were not likely to have serious impacts.

* Group C includes those problems which MEMP decided were likely to occur, but with very local and minor impacts.

* Group D includes those problems which MEMP decided were not likely to occur.

What Happens Now?

MEMP was designed to look at all the possible environmental problems associated with oil and gas development, and to determine which problems were likely to be serious enough to require some kind of attention - either through monitoring, or measures designed to reduce the problem.

By including government people, consultants, and community representatives, the MEMP organizers tried to be sure to include every possible impact on the environment that has already been noticed, or that people believe might occur as a result of hydrocarbon development. The organizers made sure to include some people who actually make a living off the land by hunting and trapping in the discussions, so that they would be sure to hear about all the problems.

Now that the MEMP Report is out, however, it is important for the public to understand that there is no single government department who is responsible for making sure that all the

recommendations get acted on. The MEMP Report was meant to be a research tool - to provide all the government departments with some directions and some ideas. But responsibility for monitoring and dealing with environmental impacts is split up among several departments, federal and territorial.

The GNWT Department of Renewable Resources will co-ordinate follow-up to the MEMP Report. They want to know what people in the region think of the conclusions and recommendations put forward by MEMP.

Contact the GNWT Department of Renewable Resources:

* if you have comments on the MEMP report conclusions - i.e. if you think they have overlooked some problems, or reached the wrong conclusions about what should be done;

* if you want to know what action is being taken on any of the MEMP recommendations.

You can contact the Department of Renewable Resources by writing or phoning the address and number below:

Department of Renewable Resources
Policy and Planning Division
Government of the N.W.T.
Yellowknife N.W.T. X1A 2L9

(403)-920-7765 or 920-8768.

LIST OF PROBLEMS BY NUMBER

Problem Statement (Original MEMP Hypothesis)	Part of the Environment Affected
Group A: Problems which are likely to occur, and likely to have serious impacts:	
Problem A-1 (MEMP #2)	Caribou
Problem A-2 (MEMP 14)	Fish
Problem A-3 (MEMP 16)	Fish
Problem A-4 (MEMP 23)	Mammals, birds and fish
Problem A-5 (MEMP 25)	Mammals, birds and fish
Group B: Problems which are possible, but not likely to have serious impacts:	
Problem B-1 (MEMP 1)	Arctic fox, red fox
Problem B-2 (MEMP 5)	Moose
Problem B-3 (MEMP 6)	Marten
Problem B-4 (MEMP 7)	Waterfowl
Problem B-5 (MEMP 8)	Raptors (eagles, falcons)
Problem B-6 (MEMP 9)	Waterfowl
Problem B-7 (MEMP 10)	Waterfowl
Problem B-8 (MEMP 11)	Waterfowl, fish, muskrat
Problem B-9 (MEMP 18)	White whale
Problem B-10 (MEMP 19)	White whale
Problem B-11 (MEMP 21)	Waterfowl
Problem B-12 (MEMP 3)	Grizzly bears

Group C: Problems which are possible, but likely to have very local and minor impacts.

Problem C-1 (MEMP 15)	Water quality, fish
Problem C-2 (MEMP 24)	Mammals, birds and fish
Problem C-3 (MEMP 16)	Fish

Group D: Problems which are not likely to occur:

Problem D-1 (MEMP 4)	Muskrat
Problem D-2 (MEMP 12)	Air quality
Problem D-3 (MEMP 13)	Fish
Problem D-4 (MEMP 17)	Wolverine
Problem D-5 (MEMP 20)	White whale
Problem D-6 (MEMP 22)	Mammals, birds and fish
Problem D-7 (MEMP 16)	Fish
Problem D-8 (MEMP 23)	Mammals, birds and fish

LIST OF PROBLEMS BY SUBJECT

Part of the Environment Affected	Problem Statement
Air quality	D-2
Caribou	A-1
Fish	A-2, A-3, B-8, C-1, D-3
Fox (Arctic and Red)	B-1
Grizzly bears	B-12
Harvest of mammals, birds and fish	A-4, A-5, C-2, D-6, D-8
Marten	B-3
Moose	B-2
Muskrat	B-8, D-1
Raptors	B-5
Water quality	C-1
Waterfowl	B-4, B-6, B-7, B-8, B-11
White whale	B-9, B-10, D-5
Wolverine	D-4

SUMMARY OF CONCLUSIONS

GROUP A: Problems which are likely to occur, and to have serious impacts (or impacts which could be serious if the problem is not dealt with).

A-1: More traffic on the Dempster Highway and roads on the North Slope will decrease the number of caribou, and change their distribution.

A-2: Improved access to fishing areas and increased fishing will decrease the numbers of fish and change their distribution.

A-3: The clearing of corridors in a straight line (seismic lines, pipeline rights-of-way) will affect the number and distribution of fish.

A-4: Changes in access will affect the harvest of fish and mammals.

A-5: Increases in hunting by outsiders will restrict harvests by local natives.

* *

GROUP B: Problems which are possible, or likely occur, but not likely to have serious impacts.

B-1: The presence of offshore drilling platforms, construction camps (and garbage), and gravel extraction will result in a decrease in the number of arctic and red foxes.

B-2: Oil and gas development construction and clearing activities, and the presence of an above-ground pipeline, will change the numbers and distribution of moose.

B-3: Oil and gas exploration and development activities that change habitat permanently or temporarily, will affect the distribution and numbers of marten.

B-4: Disturbance caused by hydrocarbon development in or near waterfowl staging, moulting or nesting areas will affect the numbers and distribution of waterfowl.

B-5: Disturbance and changes to habitat due to hydrocarbon development, will alter the distribution and/or numbers of

raptors (peregrine falcons, gyrfalcons, golden eagles and bald eagles).

B-6: The presence of camps and garbage disposal sites will attract predators that will lead to changes in the local numbers and distribution of waterfowl.

B-7: Occasional spills of crude oil and diesel fuel near staging and moulting areas of nesting colonies will reduce the numbers of waterfowl.

B-8: Land will sink lower when oil is taken out from under the surface, which will change the numbers and distribution of waterfowl, fish and muskrat.

B-9: Wage employment will change the numbers of white whales harvested.

B-10: Vessel traffic will decrease the white whale harvest.

B-11: Increased or improved access resulting from development will increase the harvest of waterfowl, which will lead to a reduction in the numbers, and a change in the distribution, of waterfowl.

B-12: The number of grizzly bears will decrease, and grizzly bear distribution will be changed, by hydrocarbon development-related activities.

* *

GROUP C: Problems which are likely to occur, but with very local and minor impacts.

C-1: (a) Waste discharges and accidental oil and/or chemical spills will lead to undrinkable water.

(b) Waste discharges and accidental oil and/or chemical spills will lead to decreased acceptability of fish as a food source.

C-2: Industrial activities in harvesting areas will reduce the harvests of mammals, birds and fish because of conflicts between industry and harvesters over land use.

C-3: The clearing of corridors in a straight line will affect fishing success.

* *

GROUP D: Problems which are not likely to occur.

D-1: Oil and gas development activities will change water levels and decrease muskrat populations.

D-2: Air discharges from oil and gas development facilities will have a negative impact on air quality.

D-3: Increased local disturbance due to activities related to hydrocarbon development will result in decreases in fish quality.

D-4: Wolverines that are attracted to camps and garbage will be killed as nuisance animals, thus reducing the population.

D-5: Hunting by outsiders will change the number of white whales landed and increase the number of deaths in the population.

D-6: Increased levels of wage employment will change the total animal harvests of resources by communities in the region.

D-7: The clearing of corridors in a straight line will affect the quality of fish.

GROUP A:
Problems which are likely to occur, and to have serious impacts.

(Note: Impacts could be serious if the problem is not addressed by monitoring, regulations, or other recommended action.)

* *

Problem A-1: More traffic on the Dempster Highway and roads on the North Slope will decrease the number of caribou, and change their distribution.

Reasons why the problem was predicted:

1. Traffic on the proposed road inland to Mt. Fitton (or through Blow Pass) will interfere with Porcupine caribou when they move to their summer range (areas where they are not bothered as much by insects) in late July and early August.

2. If caribou cannot get to windy areas where insects don't bother them as much, they will use up more energy avoiding insects; which means they will store less fat, and may also be more vulnerable to parasites.

3. Lower energy levels will affect calving success - calves will be lighter and more will die.

4. If caribou are using up more energy, they will store less fat, which will lower the quality of caribou meat.

5. Increased traffic on the Dempster Highway will increase the number of caribou killed as a result of collisions - which will decrease the numbers of caribou.

6. Increased traffic on the Dempster and other roads, will keep caribou away from habitat south of the highway and elsewhere. Caribou distribution will change and this may affect where animals are harvested, and how many are taken.

Conclusion: If caribou cannot get away from insects, there could be an effect on calf survival. There are ways to avoid this problem, such as closing the roads when the caribou are moving.

Caribou kills from collisions might increase to about 300 animals per year.

Increased traffic may cause long-term changes in caribou distribution, which may interfere with the success of hunters.

MEMP Recommendations:

Research: Research on how caribou use insect-relief areas, and effects of insect harassment on caribou health and calf survival.

Monitoring:
- aerial monitoring of caribou movements in the North Slope area in July;
- road kills sighted along the Dempster documented, to see if there are major increases;
- traffic levels on the Dempster monitored during September and October;
- data collected on the number of caribou harvested and where they are taken.

This information will help to understand changes in the distribution of the caribou herd.

.....

Problem A-2: Improved access to fishing areas and increased fishing will decrease the numbers of fish and change their distribution.

Reasons why the problem was predicted:

1) Improved access will increase fish taken for sport, for commercial use (sale) and for domestic use (eaten at home, feeding dogs, dry fish).

2) The increase in human population due to industrial development will lead to more sport fishing, and a greater number of fish harvested.

3) This increased harvest will reduce local and regional populations of sport fish - especially lake trout and Arctic char.

4) Increased domestic and commercial harvests will reduce local and regional populations of fish, and may change their distribution, especially Arctic char and lake trout.

Conclusions: Decrease in fish populations and changes in distribution are likely to occur. An attempt can be made to control overfishing by the use of regulations (quotas, limits to harvest, etc.) but such regulations are difficult to enforce,

especially in the Arctic where harvesting fish is an aboriginal right.

MEMP Recommendations:

Research: Specific research on the numbers and distribution of several species of fish is needed to allow effective management of local and regional populations - including:

- Arctic char (number and size of western populations)
- lake trout (distribution)
- whitefishes (rearing locations, overwintering and spawning areas, migrations, and key habitat areas)
- arctic grayling (population recovery times, response to fishing, harvest statistics).

Monitoring: There is a need to determine the total amount of fish harvests, both domestic and commercial, for each body of water commonly fished. Future harvests should be monitored and documented.

.....

Problem A-3: The clearing of corridors in a straight line (seismic lines, pipeline rights-of-way) will affect the number and distribution of fish.

Reasons why the problem was predicted:

1. Construction will increase sediment (loose soil and gravel on the bottom of rivers and streams) at specific locations over large areas.

2. Construction and operation activities will change the locations, size and shape of channels at specific locations.

3. More sediment production will decrease water clarity, and reduce the availability of fish foods.

4. Increased sediment and exposure to sediment will result in fish kills, health problems such as reduced growth, and changes in behaviour patterns.

5. The size of sediment material on streambeds will change.

6. Changes in channels will affect fish habitat at specific locations.

7. There may be blockage or restrictions of fish movements.

8. Decreases in water clarity will reduce angling success and increase net fishing success.

9. Local changes in the amount and quality of habitat will change numbers and distribution of fish.

10. Local restrictions in access will interfere with spawning and overwintering survival, and affect the numbers and distribution of fish.

Conclusions: Linear corridors can have an impact on numbers and distribution of fish; but these impacts can be controlled and kept to a minimum by careful route selection, careful design of stream crossings, and routine on-site supervision of construction activities.

MEMP Recommendations:

Research: A wide variety of research is needed, including:

- studies to improve the design of culverts so fish passage can be ensured during ice conditions;

- studies to determine the distribution, movements and critical habitat of whitefishes and grayling;

Monitoring: - systematic monitoring of fish, and of small animals that live on the bottom of river and stream beds;

- install more stations to collect baseline data on waste discharge and sediment.

.....

Problem A-4: Changes in access will affect the harvest of fish and mammals.

Background: Some facilities resulting from development - e.g. seismic lines, rights-of-way - can be used by people travelling to hunting, fishing and trapping areas.

Reasons why the problem was predicted:

1) Better access will reduce the time spent in harvesting activities by an individual harvester.

2) Decreased travel time may allow harvesters to travel farther,

or to spend more time at a harvesting location.

3) These changes will change harvest levels (this is probably true only for large game, i.e. moose and caribou). However, the amount of travel time saved will be small; and most hunts end when the hunters have harvested enough meat - so overall the change in harvest will probably be minimal.

4) Increased access to an area results in increased use of the area. This may lead to competition among hunters and trappers for limited resources. This may lead to an increased harvest in the area.

5) Increased access may change the locations which are used for harvesting. This may result in a change in the species which are harvested.

6) The above harvest changes might affect the distribution and abundance of animals, locally and regionally.

Conclusions: Harvesting of large game will be affected by all-weather roads. Furbearer harvest will be more affected by seismic lines. Fish harvest will be more affected by all-weather roads.

MEMP Recommendations: To be able to figure out affects on harvest, it is necessary to know the size of community harvests and individual harvests. An on-going harvest study is required to provide this detailed information. Detailed information must also be collected on changes in community access.

.....

Problem A-5: Increases in hunting by outsiders will restrict harvests by local natives.

Background: Native people currently harvest 100% of the marine mammals, nearly 100% of the furbearers, 90% of the big game and most of the fish and waterfowl taken in the region. Each community has its own traditional harvesting area, some of which are registered. There are no areas that are not used for harvesting.

Reasons why the problem was predicted:

1) Development will lead to outside people moving in.

2) This will result in an increased demand for fish and wildlife; especially native people coming in from elsewhere, and non-

native people who come in for relatively long periods of time.

3. This increased demand will result in increased effort and competition among harvesters, which will result in decreased abundance of resources.

4. This may lead to reduced local harvests, or people having to hunt longer or go farther to harvest the same amount.

5. Increased competition, or decreased availability of resources, will lead to restrictions on local native harvesters.

Conclusion: If there are no regulations put in place to protect native harvesting, all the above could happen. However, it is expected that through native claims settlements, the right of native people to harvest resources in their traditional areas will be protected. If competition for resources is still a problem, additional regulations may be required.

MEMP Recommendations: Records should be kept of the number of non-local harvesters, and their harvests. If the numbers of non-local harvesters increase a lot, the species they harvest and should be documented . When there is a concern about a specific species, more research may be needed on the numbers and distribution of the population.

GROUP B:
Problems which are possible, or likely to occur, but not likely to have serious impacts.

Problem B-1: The presence of offshore drilling platforms, construction camps (and garbage), and gravel extraction will result in a decrease in the number of arctic and red foxes.

Reasons why the problem was predicted:

1. Polar bears will be attracted to the platforms and have to be killed.

2. If there are fewer polar bears, there will be less seal dead seal meat left on the ice.

3. There will be fewer seals around the platforms - which will also mean less dead seal meat on the ice.

4. If there is less seal meat, there will be fewer arctic foxes.

5. Camps and garbage will attract arctic and red foxes (because of available food). Foxes may be attracted from other areas. This will mean fewer foxes to be trapped elsewhere, and more foxes available for trapping around the camps.

Conclusion: Foxes follow polar bears and can travel long distances for their food. There should not be noticeable impacts on fox populations from platforms and gravel extraction. The distribution of fox populations, and their numbers, varies from year to year naturally.

Impacts caused by availability of garbage can be avoided through careful management.

MEMP Recommendations:

Research and Monitoring:

- more information on fox travel rates, pattern of movements, and what breeding populations the foxes on sea ice come from;
- a tagging program at drilling sites to figure out whether the same foxes remain around camps for long periods of time, or if foxes are continuously coming and going.

Other: Garbage treatment and public education.

.....

Problem B-2: Oil and gas development construction and clearing activities, and the presence of an above-ground pipeline, will change the numbers and distribution of moose.

Background:

There are three major types of activities might affect moose -

1) increased traffic levels on permanent roads;
2) effects of an above-ground pipeline on moose movements;
3) clearing of forested areas.

Reasons why the problem was predicted:

1) Clearing of forested area (for wood-chipping, seismic lines and pipeline rights-of-way) will increase the amount of food available to moose in the short term, by creating new browsing areas.

2) Construction activities and traffic will disturb female and young moose, or the general moose population, enough to cause them to relocate, thereby causing a major change in the distribution of moose.

3) Increased traffic on permanent roads, such as the Dempster Highway, will result in an increased number of moose kills through collisions.

Conclusion: None of the factors outlined above will cause a noticeable overall change in the distribution of moose. Moose in Alaska pass beneath raised pipelines.

MEMP Recommendations:

Research:

- continued basic research on the numbers, movements, and behaviour patterns of moose populations in the NWT.

Monitoring:

- woody browse areas created by clearing should be monitored to see how long they take to grow back;
- road kills of moose should be reported and documented;
- if above-ground pipelines are built, moose movements along the pipeline should be monitored for the first two or three years of operation.

.....

Problem B-3: Oil and gas exploration and development activities that change habitat permanently or temporarily, will affect the distribution and numbers of marten.

Background: Marten are solitary animals. They live in mature forests and tend to avoid areas with little ground cover . They den primarily in hollow trees and fallen logs in mature forests.

Reasons why the problem was predicted:

1) Possible impacts on marten include:

- temporary decrease in area suitable for marten denning due to clearing operations;
- permanent decrease in area suitable for denning due to permanent roads, facilities and borrow pits;
- temporary increase in area suitable for feeding due to clearing operations;
- permanent decrease in area suitable for feeding due to permanent roads, facilities and borrow pits.

2) Effects of these impacts could include:

- decrease in local breeding population of marten;
- increase in the local breeding population of marten;
- movement of marten to other areas.

Conclusion: Activities associated with oil and gas development will result in both a temporary and permanent loss of forest cover, but these habitat changes will affect only a small part of many marten territories. Changes in numbers and distribution of marten are not expected to affect the total population.

MEMP Recommendations:

Research: Research on the size of marten home ranges is planned by GNWT Renewable Resources for 1986-87.

.....

Problem B-4: Disturbance caused by hydrocarbon development in or near waterfowl staging, moulting or nesting areas will affect the numbers and distribution of waterfowl.

Reasons why the problem was predicted:

1. Waterfowl may be disturbed by any of the following factors:

- increase in aircraft overflights;
- presence of exploratory, processing and distribution facilities (i.e. buildings, borrow pits, pipelines, compressor stations, communication towers, roads and highways)
-increased vessel traffic on the Mackenzie River;
-increased access by people to waterfowl summering and nesting habitat.

2. This disturbance will displace waterfowl, and interfere with feeding, courtship and nesting.

3. An increase in disturbance will cause waterfowl to desert their nests, and eggs or chicks will be lost.

4) Increased nest desertion and brood loss will reduce the birth rate, which will reduce the numbers and change the distribution of waterfowl. This is probably most true for waterfowl which nest in colonies (groups) such as snow geese and brant.

5. The presence of towers and wires will increase death rates of water-fowl.

Conclusion: The overall effects of disturbance will be minimal and not noticeable at the level of regional populations of waterfowl because:
- studies showed that oil field activities at Norman Wells had only minor effects on waterfowl;
- waterfowl around Norman Wells were affected more by weather and environmental factors than by oil field activities;
- aircraft overflights did not have much impact;
- only a small part of waterfowl habitat along the river would be interfered with;
- spring staging areas are not easy for tourists to get to.

The only area of real concern is disturbance of nesting populations due to increased human access.

MEMP Recommendations:

Monitoring: Information on land-use activities of residents and visitors should be collected on a community by community basis, to alert government biologists to areas of potential impact;

Other: Public awareness programs should be initiated to make people aware of the potential dangers of interfering with waterfowl.

.....

Problem B-5: Disturbance and changes to habitat due to hydrocarbon development, will alter the distribution and/or numbers of raptors (peregrine falcons, gyrfalcons, golden eagles and bald eagles).

Reasons why the problem was predicted:

1) Tall structures constructed during hydrocarbon development will increase gyrfalcon populations because:
- Ravens and rough-legged hawks will establish nest sites in tall structures.
- Gyrfalcons will take over some of these nests.
- Because gyrfalcon breeding areas are limited on the tundra, these nests will provide new habitat for adults.

2) Development will result in increased stealing of peregrine and gyrfalcon eggs and cause a decrease in the numbers of these species because:
- roads, pipeline rights-of-way and seismic lines will allow access to nest sites;
- increased access will lead to increased stealing.
- this will cause a reduction in falcon populations.

3) Borrow pits will change the number of raptor nest sites because:
-borrow sites can destroy nesting habitat located at rock quarries;
- borrow sites can create new raptor nesting habitat after the sites are abandoned.

4) Nesting raptors will be disturbed by:

- low-altitude aircraft flights;
- increased numbers of people and activity;

and this disturbance will lead to fewer young being born due to nest abandonment, egg loss because of neglect by parents, death of chicks due to abandonment, or decreased health of chicks resulting from insufficient feeding.

This will lead to a reduction in raptor populations.

Conclusion: The overall effect of all these impacts is expected to be small, especially because raptor populations change from year to year naturally.

MLMP Recommendations:

Monitoring: - continue routine monitoring of raptor populations that is already underway;

Other: - regulations to prevent disturbance of raptors at nest sites should be imposed by the government and enforced.

.....

Problem B-6: The presence of camps and garbage disposal sites will attract predators that will lead to changes in the local numbers and distribution of waterfowl.

Reasons why the problem was predicted:

1) Camps and garbage disposal sites in an area will cause local increases in the number of animals that kill waterfowl, including bears, foxes, jaegers, gulls and ravens.

2) Nesting or moulting waterfowl near camps and garbage disposal sites will be in danger of increased killing.

3) Increased killing will cause a decrease in the numbers, and change the distribution, of waterfowl.

Conclusion: If proper handling procedures for garbage are followed, there will not be much loss of waterfowl due to increased killing.

MEMP Recommendations:

Proper garbage disposal practices be followed.

.....

Problem B-7: Occasional spills of crude oil and diesel fuel near staging and moulting areas of nesting colonies will reduce the numbers of waterfowl.

Reasons why problem was predicted:

1) When waterfowl are in the area of an oil slick, physical contamination of the birds will occur.

2) Death of waterfowl will occur following physical contamination by oil.

3) Waterfowl will eat oil by taking in contaminated food or preening feathers coated with oil.

4) Waterfowl will die from taking in oil; or else their resistance to disease will be lessened and more will die than is normal.

5) Quality of waterfowl flesh will be reduced if oil is taken in.

Conclusion: Whether or not waterfowl will die from occasional oil spills depends on a number of factors - frequency of spills, volume of oil spilled, oil type, time of year, etc. Death of waterfowl from oil spills is expected to be low.

MEMP Recommendations

Monitoring: - any deaths of waterfowl resulting from oil spills in the area should be documented;
- if oil spills increase in number and in volume of oil spilled from present levels, then it may be necessary to implement a monitoring program.

.....

Problem B-8: Land will sink lower when oil is taken out from under the surface, which will change the numbers and distribution of waterfowl, fish and muskrat.

Reasons why the problem was predicted:

1) Lowering of the ground over Mackenzie Delta oil fields will be caused by the withdrawal of oil; and by thawing of the permafrost layer.

2) Lowering of the ground surface will cause a change in the ground temperature and in water levels.

3) These changes will cause a change in the amount, and quality, of habitat for muskrat, waterfowl and fish, which will cause a change in their numbers.

Conclusion: The changes in the area and quality of habitat for waterfowl, fish and muskrat will be so small that they will not be important, if the predictions about how much the land will

sink are correct.

MEMP Recommendations:

Research:
- the structure of the earth and rock foundation of the Niglintgak area should be studied and compared to areas where lowering of the ground has occurred;
- further research is needed on permafrost, and distribution of permafrost in areas of hydrocarbon reservoirs.

Monitoring:
- the Niglintgak oil field should be monitored for effects of sinking of land in an area of permafrost;
- the ground surface should be monitored prior to and during production to determine how much the land sinks;
- site-specific biological data should also be collected.

.....

Problem B-9: Wage employment will change the number of white whales harvested.

Reasons why the problem was predicted:

1) Wage employment in the Delta will result in less time available for hunting.

2) The reduced time available may cause hunters to be more willing to take the first available whale, rather than waiting for the preferred larger older males. This may result in a change in the age and sex of whales that are killed.

3) Wage employment will change the make-up of hunting groups, because some men will not be available for hunting.

4) A change in the make-up of hunting groups will lead to a decrease in the general level of hunting skills, as fewer people are engaged in hunting and spending less time in camps.

5) Wage employment may help hunters to purchase better and more efficient hunting equipment. But if their hunting skills are not developed, due to less time spent hunting, they may not have the knowledge required to decide which is the best equipment.

6) Less skillful hunters and a change in the quality of equipment may lead to a greater number of lost whales.

7) The increase in lost whales will increase white whale deaths.

Conclusions: Wage employment may change the make-up of the harvest - i.e.the age and sex of whales harvested - but it is not expected to change the number of animals harvested. Regulations or quotas can be used to control the number of whales lost.

MEMP Recommendations:

The monitoring program now underway by Dept. of Fisheries and Oceans on white whale harvests should be continued, and expanded to include information about the employment status of hunters.

.....

Problem B-10: Vessel traffic will decrease the white whale harvest.

Reasons why the problem was predicted:

Vessel traffic will directly interfere with hunting activities and reduce the time available for hunting.

Conclusion: Present levels of vessel traffic have not affected the level of white whale harvest. It is unlikely that the amount of vessel traffic resulting from proposed development would affect the harvest.

MEMP Recommendations:

If development plans change and there is a potential for interference with white whale harvest, monitoring programs should be increased.

.....

Problem B-11: Increased or improved access resulting from development will increase the harvest of waterfowl, which will lead to a reduction in the numbers, and a change in the distribution, of waterfowl.

Reasons why the problem was predicted:

1) Development will increase or improve access to areas which support waterfowl populations; e.g. roads, pipeline rights-of-way, and seismic lines.

2) This will increase the harvest of waterfowl - especially the proposed Inuvik-Tuktoyaktuk road, which would pass through an area used by snow geese in the spring.

Conclusion: With the present development plan , there is not much danger of increased waterfowl harvest. There is no commitment by any government department or industry to build the Inuvik-Tuktoyaktuk road at this time. However, if that road is to be built in the future, there may be an increase in waterfowl harvests.

It would be difficult to document such an increase, as there are no records kept on waterfowl harvest at present.

MEMP Recommendations: None.

.....

Problem B-12: The number of grizzly bears will decrease, and grizzly bear distribution will be changed, by the following activities:

- **gravel extraction**
- **construction**
- **seismic exploration**
- **other development activities**
- **presence of camps and garbage.**

Reasons why the problem was predicted:

1. Construction activities during late summer will disrupt feeding activity of bears, and make them move around more. This will prevent the bears from gaining weight and storing the fat they need for fall.

2. Bears need fat reserves to produce healthy cubs, survive the winter and produce healthy fur.

3. Construction and seismic activities in winter will cause bears to abandon their dens - which will interfere with birth of young and overwinter survival.

4. The grizzly bear population will decrease if cubs aren't born or if bears don't survive the winter.

5. Grizzly bears that are attracted to camps and garbage may be destroyed.

Conclusion: All these activities except gravel extraction could have an impact on grizzly bear populations, but they are

not a serious problem. Conflicts between bears and humans at camps can be controlled by careful disposal of garbage and other regulations. Summer construction activities will not be so large-scale that they will significantly affect bear feeding. And gravel extraction will happen only in a very small portion of possible bear denning area.

MEMP Recommendations:

Research and Monitoring:

- records be kept of numbers of bears observed and killed near camps;
- more bear awareness programs to educate the public about how to deal with bears;
- more research into how to deter bears without killing them (e.g. rubber bullets);
- continue research project where they put radio collars on bears near Richards Island to find out about their movements and feeding patterns around industrial activity.

GROUP C:
Problems which are likely to occur, but with very local or minor impacts.

Problem C-1(a): Waste discharges and accidental oil and/or chemical spills will lead to undrinkable water.

Problem C-1(b): Waste discharges and accidental oil and/or chemical spills will lead to decreased acceptability of fish as a food source.

Background: Contaminants from industrial development will be discharged into water systems. There is also a risk of accidental oil and chemical spills. Contaminants will include crude and refined oils, heavy metals, bacteria and viruses in sewage, and various chemicals.

Reasons why the problem was predicted:

C-1(a)

1) Direct discharges of contaminants will increase their amount in rivers, streams and lakes.

2. Discharge of contaminants to treatment ponds will lead to their build-up in underground waters.

3. Spills on the ground will lead to increased amounts of contaminants in underground waters.

4. Increased contaminants in subsurface waters will lead to increased amounts in surface waters - which will lead to a decrease in the suitability of water sources for drinking.

C-1(b)

1. Increased amounts of contaminants in surface waters will result in:

- increased amounts of contaminants in sediment;
- increased amounts of contaminants taken in by fish;
- increased contaminants build-up in the bodies of fish that eat plants or animals from the water;

Increased amounts of contaminants in sediments will lead to:

- increased contaminant build-up in bottom-feeding fish and small animals and organisms that live on the bottom of water bodies;

This will also lead to increased amounts of contaminants in fish

that eat other fish and small animals. The overall results will be decreased acceptability of fish as a food source by local residents.

Conclusion: Waste discharges from industrial activity are unlikely to cause water sources to become undrinkable, except on a very local scale (e.g. small lakes, ponds). Of greatest concern is the contamination of inland water supplies that are used by hunters travelling overland.

It is unlikely that the proposed level of activity will cause fish to become not suitable for eating through release of contaminants. However, although there have not been any complaints of tainted fish in the study area, there have been complaints of abnormal loche livers and soft, watery fish flesh.

MEMP Recommendations:

Research: - case study on what happens to contaminants in the vicinity of an abandoned waste sump.

Monitoring: On-going monitoring on the concentrations of hydrocarbons and heavy metal in fish now being done by DFO should continue.

.....

Problem C-2: Industrial activities in harvesting areas will reduce the harvests of mammals, birds and fish because of conflicts between industry and harvesters over land use.

Reasons why the problem was predicted:

1)Industrial activity will result in conflicts between industry and harvesters. This could happen in three ways:

- Destruction of property (traps, cabins, snowmobiles)

- Damage to habitat (spills in lakes, damage to muskrat areas)

- Restrictions on land use for short or long periods of time.

2) These conflicts may result in areas of land not being available for harvesting, either for a short or long period of time.

3) Changes in location of some harvesters will reduce individual

and community harvests.

4) Harvesters may move into someone else's harvesting area and come into conflict with harvesters who are already using that area.

Conclusion: Land use conflicts may result in reduced harvests, especially for trappers. Impacts will probably be felt at the local and individual level.

MEMP Recommendations:

If reduced harvests do occur, then compensation will be required. It will be useful to have harvest and land use information on file to support compensation claims. The need for research into harvests has been outlined under Problems A-4 and A-5.

Three kinds of information are required:

- location of proposed and probable industrial development and existing land use by native harvesters will be needed to design measures to avoid conflicts;

- a way to figure out the actual effects of conflict on harvests will be needed ;

- the effectiveness of existing negotiation, mitigation and compensation mechanisms should be evaluated.

It will also be important to figure out if harvesters' levels of effort change as a result of industrial activity.

Finally, data on location of harvests and industry activities must be collected and kept up-to-date.

.....

Problem C-3: The clearing of corridors in a straight line will affect fishing success.

Reasons why the problem was predicted: See A-3 above.

Conclusion: Because it was determined in (16-A) above that clearing of corridors will affect fish numbers and distribution, there are likely to be very minor and localized impacts on fishing success.

MEMP Recommendations: None.

GROUP D:
Problems which are not likely to occur

Problem D-1: Oil and gas development activities will change water levels and decrease muskrat populations.

Background:

Muskrats in the Mackenzie Delta rely on predictable seasonal water levels. Increases to those levels can cause flooding of breeding chambers and allow greater access by predators under the ice in winter. Decreases in water levels can reduce the available breeding habitat.

Reasons why the problem was predicted:

1) Some hydrocarbon development facilities (drilling rigs, etc.) take out water and then return it to natural sources. Water is used for production wells, testing of pipelines, and other purposes; and camps.

2) Physical barriers like pipeline berms, staging areas, and access roads, may interrupt drainage patterns.

Conclusion: Water will be taken mainly from large sources like the Mackenzie River which will not be affected. Drainage patterns are only likely to be interrupted in areas where muskrats are not harvested. No significant decrease in muskrat populations is expected. Local groups of muskrats may be affected but only on a short-term basis. A large area of prime muskrat habitat would have to be affected before changes in the overall population would occur.

MEMP Recommendations: None.

.....

Problem D-2: Air discharges from oil and gas development facilities will have a negative impact on air quality.

Background: Hydrocarbon development has the potential to release pollutants into the air through the following processes:

1) Burning of garbage
2) Burning of diesel fuel
3) Burning gas
4) Gas flaring
5) Evaporation from fuel tanks
6) Burning propane

Because this issue is very technical, one scientist was asked to study the question and put together predictions on how much pollution would be released, under certain development conditions.

Conclusion: Regional air quality will not be affected enough to need a monitoring program throughout the region.

MEMP Recommendations:

Monitoring: - local monitoring of emissions at the source to monitor local effects - such as ice fog.

.....

Problem D-3: Increased local disturbance due to activities related to hydrocarbon development will result in decreases in fish quality.

Reasons why the problem was predicted:

1) Increased local disturbance (e.g. additional barge traffic) will result in fish using up more energy.

2) Higher energy use will result in decreased fish quality for eating (taste, appearance, firmness of flesh).

Conclusion: Fish quality will not be affected because:

- there is no evidence to show that disturbance has affected the taste or quality for eating of northern fishes;
- in the proposed developments, there is no activity that would cause enough disturbance to make fish use up more energy;
- greater sources of disturbance in southern waters have never been identified as a cause of decreased fish quality;
- sport fishing can be considered an extreme form of disturbance, since it exhausts fish, but there have been no reports of fish caught in this way with decreased quality.

MEMP Recommendations: None.

.....

Problem D-4: Wolverines that are attracted to camps and garbage will be killed as nuisance animals, thus reducing the population.

Background:

Wolverines have large home ranges and are spread out over large areas. This makes it hard to predict how many animals can be attracted by a single camp.

Conclusions: Because wolverines are not dangerous to people, they can be removed from camps without killing them. This is a management problem.

MEMP Recommendations:: Trapping and hunting around camps should be limited or prevented.

.....

Problem D-5: Hunting by outsiders will change the number of white whales landed and increase the number of deaths in the population.

Conclusion: It is not likely that hunting by non-local hunters will increase the harvest or death rate of white whales. Outside hunters are not likely to have their own gear; they will either return to their home communities to hunt or else team up with local hunters.

MEMP Recommendations: None.

.....

Problem D-6: Increased levels of wage employment will change the total animal harvests of resources by communities in the region.

Conclusion: This is not expected to happen as long as:

1) Wage employment is flexible, with respect to timing, location and length of employment;

2) Income from employment is enough to allow harvesters to outfit themselves;

3) The system of sharing and helping one another within communities continues;

4) The level of skills, and distribution of skills among hunters, in the community remains pretty much the same.

MEMP Recommendations:

Research: In order to determine the impacts of wage employment on harvesting, more research is needed in the following areas:

1) Wage employment: Information on the number of people who have jobs; their age, sex, occupation, how long they are employed, and wage rates.

2) Effort: Case studies (studies of individual hunters) done to get a better idea of how much gear is used for different types of harvesting; cost of an outfit; amount of time spent on harvesting; and levels of skill required to be an effective harvester.

3) Harvests: Harvests monitored by community for each species. Annual community totals for each species should be recorded.

4) Sharing within communities: The system of sharing of harvest products (meat, furs and hides) within communities studied and recorded, so that changes in the system can be monitored and documented.

.....

Problem D-7: The clearing of corridors in a straight line will affect the quality of fish.

Reasons why the problem was predicted: See A-3.

Conclusion: Although it was concluded in A-3 above that clearing of corridors may affect the numbers and distribution of fish, it is not expected to affect fish quality.

MEMP Recommendations: none.

.....

Problem D-8: Changes in access will affect the harvest of

waterfowl.

Reasons why the problem was predicted: See A-4.

Conclusion: The improved opportunities for access resulting from seismic lines, all-weather roads, etc. are not expected to be associated with waterfowl staging and nesting sites.

MEMP Recommendations: None.

LIST OF TERMS USED IN THIS REPORT

(These definitions explain how these terms are used in this report.)

Borrow pits:	areas where rocky soil and gravel are dug out of the ground for use in gravel pads and other facilities.
Breeding:	time when animals are giving birth or raising their young.
Browsing areas:	areas where moose eat.
Contaminant:	any substance which is put into the environment by human activity.
Contamination:	pollution of an area or body water by contaminants.
Distribution:	the way in which a population of a species of animals are spread out over an area.
Effort:	a combination of the time spent in harvesting activities, amount and type of equipment, and the harvesters' skills.
Furbearers:	marten, lynx, beaver, muskrat, wolverine.
Gravel extraction:	taking gravel out of the ground (see "borrow pits").
Habitat:	the kind of landscape in which a certain species of animal lives.
Harvest:	the number of animals taken by hunting, trapping or fishing; can refer to the number actually killed or the number taken home and used by the harvester.
Harvester:	someone who uses the resources of the land, usually by hunting, trapping or fishing.
Hydrocarbon:	oil and/or gas.
Impact:	a change or noticeable effect on the environment as a result of development or human activity.
Insect-relief area:	high windy place where caribou go to get away from mosquitoes and blackflies.

Monitoring:	watching parts of the environment (wildlife, air, water, land) to see what changes take place that may be a result of development.
Population:	all the members of a certain species in a specific area.
Raptors:	eagles and falcons.
Right-of-way:	cleared area for a pipeline.
Sediment:	mud, soil or gravel on the bottom of a body of water.
Staging area:	areas where waterfowl stop over during migration.
Wage employment:	work that is done for money rather than as part of the traditional lifestyle.
Waterfowl:	ducks, geese, swans.

APPENDIX 1

LIST OF PARTICIPANTS
1985 MACKENZIE ENVIRONMENTAL MONITORING PROJECT WORKSHOP
Edmonton, Alberta
November 4-8, 1985

Alberta Adams
Mackenzie Delta Regional Council
Box 1509
Inuvik, N.W.T. X0E 0T0
Research Interests: Wildlife and harvest management.

Jim Allard
Metis Association
Fort Good Hope
Northwest Territories
Research Interests: Wildlife and harvest management.

Lorraine Allison
Salix Enterprises Limited
Box 200
Cowley, Alberta T0K 0P0
Research Interest: Resource harvesting, social and cultural changes.

Terry Antoniuk
Gulf Canada Resources Inc.
P.O. Box 130
Gulf Canada Square
Calgary, Alberta T2P 2H7
Research Interests: Fisheries biology, northern development.

Alex Aviugana
Box 2123
Inuvik, N.W.T. X0E 0T0
Research Interests: Wildlife and harvest management.

Alan Birdsall
LGL Limited
9768 Second Street
Sidney, B.C. V8L 3Y8
Research Interests: Resource management; environmental biology.

Bill Brakel
Environment Canada
Twin Atria #2
2nd Floor, 4999 - 98 Avenue
Edmonton, Alberta T6B 2X3
Research Interests: Northern economic and environmental change.

Doug Bruchett
Petro Canada Resources
P.O. Box 2844
Calgary, Alberta T2P 3E3
Research Interests: Social effects of hydrocarbon development.

Andrew Cullen
Northern Affairs Program
Indian and Northern Affairs
Box 1500
Yellowknife, N.W.T. X1A 2R3
Research Interests: Effects monitoring.

Debbie DeLancey
Fort Good Hope
Northwest Territories
Research Interests: Resource harvesting; social and cultural changes.

Lynne Dickson
Environment Canada
2nd Floor, 4999 - 98 Avenue
Edmonton, Alberta T6B 2X3
Research Interests: Waterfowl biology.

Lee Doran
Polar Gas
Box 90
Toronto, Ontario M5L 1H3
Research Interests: Environmental effects of linear development

George Edwards
Hunters and Trappers Association
Aklavik
Northwest Territories X0E 0A0
Research Interests: Wildlife and harvest management.

Albert Elias
Holman Island, N.W.T. X0E 0S0
Research Interests: Wildlife and harvest management.

Bob Everitt
ESSA Environmental and Social Systems Analysts Limited
Box 12155 - Nelson Square
Vancouver, B.C. V6Z 2H2
Research Interests: Research planning, resource harvesting.

Susan Fleck
Department of Renewable Resources
Government of Northwest Territories
Yellowknife, N.W.T. X1A 2L9
Research Interests: Wildlife management.

Alan Gell
Invermuir Road
R.R. #2
Sooke, B.C. V0S 1N0
Research Interests: Terrain and geomorphology.

Ron Graf
Department of Renewable Resources
Government of Northwest Territories
Yellowknife, N.W.T. X1A 2L9
Research Interests: Wildlife biology management.

Rick Hurst
Indian and Northern Affairs Canada
Northern Environment
Les Terrasses de la Chaudiere
Ottawa, Ontario K1A 0H4
Research Interests: Impact assessment and monitoring.

Harvey Jessup
Department of Renewable Resources
Government of Yukon
P.O. Box 2703
Whitehorse, Yukon
Y1A 2C6
Research Interests: Wildlife management.

Michael Jones
ESSA Environmental and Social Systems Analysts Limited
Suite 102
66 Isabella Street
Toronto, Ontario M4Y 1N3
Research Interests: Modeling, aquatic ecology.

Rick Josephson
Department of Fisheries and Oceans
501 University Crescent
Winnipeg, Manitoba R3T 2N6
Research Interests: Resource management; fish biology.

David Krutko
Beaufort/Delta DIZ Society
P.O. Box 30
Fort McPherson, N.W.T. X0E 0J0
Research Interests: Wildlife and harvest management.

Peter McCart
Box 78
Spruce View, Alberta T0M 1V0
Research Interests: Fish biology; effects of development on fish.

John McDonald
ESL Environmental Sciences Limited
2035 Mills Road
Sidney, B.C. V8L 3S1
Research Interests: Environmental assessment, hydrology.

Fred McFarland
Northern Environment Directorate
Indian and Northern Affairs Canada
Ottawa, Ontario K1A 0H4
Research Interests: Effects of industrialization of the north, wildlife biology.

Margaret McLaren
LGL Limited
P.O. Box 457
King City, Ontario LOG 1KO
Research Interests:: Wildlife biology.

Peter McLaren
LGL Limited
P.O. Box 457
King City, Ontario LOG 1KO
Research Interests: Waterfowl biology impact assessment.

Peter McNamee
ESSA Environmental and Social Systems Analysts Limited
Suite 102
66 Isabella Street
Toronto, Ontario M4Y 1N3
Research Interests: Ecological modelling; research planning.

Steve Matthews
Department of Renewable Resources
Government of Northwest Territories
6th Floor, Courthouse
Yellowknife, N.W.T. X1A 2L9
Research Interests: Wildlife management, northern development

Maurice Mendo
Great Bear DIZ Society
Fort Norman
Northwest Territories
Research Interests: Wildlife and harvest management.

Mike Miles
M. Miles & Associates Limited
502 Craigflower Road
Victoria, B.C. V9A 2V8
Research Interests: Hydrology, impacts of development on streams.

David Mossop
Department of Renewable Resources
Government of Yukon
P.O. Box 2703
Whitehorse, Yukon Y1A 2C6
Research Interests: Avian ecology, raptor biology.

Heather Myers
Department of Renewable Resources
Government of Northwest Territories
Yellowknife, N.W.T. X1A 2L9
Research Interests: Utilization of resources.

Wendy Nixon
Canadian Wildlife Service
Room 202
204 Range Road
Whitehorse, Yukon Y1A 4X4
Research Interests: Wildlife biology.

Pamela Norton
PN Research Projects
P.O. Box 2296
Sidney, B.C. V8L 3S8
Research Interests: Harvesting of white whales, marine mammal biology.

Chris O'Brien
Dene Nation
Box 2338
Yellowknife, N.W.T. X1A 2P7
Research Interests: Northern resource use; environmental effects of development.

Ed Pessah
Dome Petroleum
P.O. Box 200
Calgary, Alberta
T2P 2H8
Research Interests: Environmental effects of hydrocarbon development.

Archie Pick
Interprovincial Pipelines (N.W.) Ltd.
P.O. Box 398
Edmonton, Alberta T5J 3N7
Research Interests: Environmental effects of linear developments.

Jim Pierrot
Mackenzie/Great Bear DIZ Society
P.O. Box 449
Norman Wells, N.W.T. XOE OVO
Research Interests: Wildlife and harvest management.

Aaron Sekerak
LGL Limited
9768 Second Street
Sidney, B.C. V8L 3Y8
Research Interests: Arctic fish biology; effects of northern development on aquatic resources.

Cal Sikstrom
ESSO Resources Canada Limited
237 - 4th Avenue S.W.
Calgary, Alberta T2P 0H6
Research Interests: Fish biology; effects of hydrocarbon development.

Nicholas Sonntag
ESSA Environmental and Social Systems Analysts Limited
Box 12155 - Nelson Square
Vancouver, B.C. V6Z 2H2
Research Interests: Research planning, environmental impacts.

Jeff Stein
Department of Fisheries and Oceans
501 University Crescent
Winnipeg, Manitoba R3T 2N6
Research Interests: Fisheries management.

David Stone
Indian and Northern Affairs Canada
Les Terrasses de la Chaudiere
Ottawa, Ontario K1A 0H4
Research Interests: Environmental effects of northern development

Tom Strong
Department of Fisheries and Oceans
Marine Mammal Management
501 University Crescent
Winnipeg, Manitoba R3T 2N6
Research Interests: Marine mammal biology, harvesting.

Dave Sutherland
Environmental Protection Service
Environment Canada
Yellowknife, N.W.T. X1A 2N3
Research Interests: Environmental effects of development.

Glen Sutherland
ESSA Environmental and Social Systems Analysts Limited
Box 12155 - Nelson Square
Vancouver, B.C. V6Z 2H2
Research Interests: Environmental monitoring, modelling.

Dave Thomas
Arctic Laboratories Limited
2045 Mills Road
Sidney, B.C. V8L 3S1
Research Interests: Chemical limnology, chemistry of hydrocarbons and contaminants.

Peter Usher
P.J. Usher Consulting Services
Box 4815, Station E
Ottawa, Ontario K1S 5H9
Research Interests: Social change in the north, resource utilization.

John Ward
Dome Petroleum
P.O. Box 200
Calgary, Alberta T2P 2H8
Research Interests: Ornithology; environmental effects of hydrocarbon development.

Robert Wolfe
Alaska Department of Fish and Game
Subsistence
Box 3-2000
Juneau, Alaska 99802
Research Interests: Resource utilization.

Walt Younkin
Hardy Associates (1978) Limited
221 - 18th Street S.E.
Calgary, Alberta T2E 6J5
Research Interests: Terrestrial ecology, geomorphology.